



# Neutrinos at Fermilab

## *A Coherent Path to DUNE*

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Briefing to DOE OHEP

Tues 12 Jan 2021

# Overview

- Neutrino Physics
  - Why are Neutrinos Important? – Quantity, Ubiquity, Oddity
  - The Current, Big, Neutrino Questions
  - Addressing the Questions
  - Physics with Neutrinos from Accelerators
- Fermilab's Current and Future Neutrino Experiments
  - MicroBooNE – Matt Toups
  - ICARUS and SBND – Angela Fava
  - NOvA – Louise Suter
  - DUNE – Jen Raaf
- Neutrinos at Fermilab
  - It all leads to DUNE and Fermilab Neutrino Scientists are organized to that end
  - Fermilab Neutrino Scientists facilitate the wider neutrino community

# Principles Governing how Fermilab deploys its Neutrino Scientific Resources

- It all leads to DUNE
- Resources are deployed where they can have most impact. Fermilab involvement should be a game changer
- Leverage other Fermilab capabilities (e.g. computing, beam,...)
- Focus on a handful of areas with strong groups in each

# Areas of Focus for Fermilab Neutrino Scientists

- The principles of the preceding slide lead us to focus the Fermilab neutrino scientists in the following 7 areas (alphabetic order)
  - Cold Electronics and LAr Light Collection
  - Collaboration management
  - Computing for Neutrino Experiments
  - Neutrino Analysis
  - Neutrino Beams
  - Neutrino Cross-Section and DUNE Near Detector
  - Slow Controls, High Voltage, Cryo

# FY21 plan for Neutrino IF Research FTE

- Total labor cost \$12,824k
- 41.63 FTE from headcount of 66
  - People charge effort to other B&Rs (e.g. Operations, ECA, Program Support) so their FTE often does not sum to 1.0 in this matrix
- Peoples effort (FTE) in a matrix of experiment (cols) vs focus area (rows)
  - cols in total FTE order, rows in alphabetical order
- People work in a focus area (or two) and what they do on NOvA, MicroBooNE, SBN etc is being or will be applied to DUNE
  - Over the next decade FTE number will move from right to left in this matrix and all end up on DUNE
  - You should really think about all FTE in this matrix as DUNE FTE

Group	Item/Employee	Division	DUNE	SBN	MicroBooNE	NOvA	Liquid Argon R&D	MINERvA	Grand Total
Cold Electronics and LAr Light Collection	Christian, D	Senior Scientist	ND	0.99					0.99
	Himmel, Alexander	Scientist	ND			0.43			0.43
	Marchionni, Alberto	Senior Scientist	ND	0.59					0.59
	Mishra, Shekhar	ND	1						1.00
	Para, Adam	Senior Scientist	ND	0.35					0.35
	Stancari, Michelle	Senior Scientist	ND	0.05	0.5	0.2			0.75
	Verzocchi, Marco	Senior Scientist	ND	0.5					0.50
Collaboration Management	Zennaro, Joseph	Associate Scientist	ND	0.3	0.6	0.1			1.00
	Cavanna, Flavio	Senior Scientist	ND	1					1.00
	Fava, Angela	Scientist	ND		0.9				0.90
	James, Catherine	Applications Physicist IV	ND			0.28			0.28
	Montanari, Claudio	Guest Scientist	ND		1				1.00
	Palamara, Ornella	Senior Scientist	ND	0.05	0.83				0.88
	Schukraft, Anne	Scientist	ND		0.92	0.03			0.95
Computing for Neutrino Experiments	Shanahan, Peter	Senior Scientist	ND				0.73		0.73
	Wilson, Peter	Senior Scientist	ND		0.08				0.08
	Zeller, Gerilyn	Deputy Division Head	ND	0.09		0.56			0.65
	Allaga Soplin, Leonidas	Research Associate	SCD				0.5		0.50
	Ceratti, Giuseppe Benedetto	Associate Scientist	SCD			0.55			0.55
	Fuess, Stuart C	Deputy Division Head	SCD	0.02					0.02
	Gardiner, Steven James	Research Associate	SCD			0.54			0.54
Neutrino Analysis	Greenlee, Herbert	Senior Scientist	ND			1			1.00
	Junk, Thomas	Senior Scientist	ND	1					1.00
	Ketchum, Wesley Robert	Scientist	ND		0.17	0.31			0.48
	Kirby, Michael H	Senior Scientist	SCD			0.41			0.41
	Norman, Andrew J	Senior Scientist	SCD	0.2			0.23		0.43
	Snider, Erica L	Senior Scientist	SCD			0.46			0.46
	Wospakrik, Mariannette	Research Associate	SCD		0.05	0.53			0.58
Neutrino Beams	Berkman, Sophie	Research Associate	SCD			0.545			0.55
	Caratelli, David	Research Associate	ND	0.2		0.8			1.00
	Del Tutto, Marco	Research Associate	ND		0.4	0.1			0.50
	Howard, Bruce	Research Associate	ND		1				1.00
	Jeria, Deepika	Research Associate	SCD					0.5	0.50
	NEW HIRE POSTDOC3	Research Associate	ND		0.25				0.25
	Norrick, Anne	Research Associate	ND	0.2			0.8		1.00
Neutrino Cross-Sections and DUNE Near Detector	Psihas, Fernanda	Research Associate	ND	0.17	0.49				0.66
	Toups, Matthew	Scientist	ND	0.14	0.15	0.5			0.79
	Wu, Wanwei	Research Associate	ND	0.85		0.15			1.00
	Yang, Tingjun	Associate Scientist	ND	0.2		0.3			0.50
	Zettlemoyer, Jacob	Research Associate	ND		1				1.00
	Fields, Laura	Scientist	SCD					0.13	0.13
	Mokhov, Nikolai	Distinguished Scientist	AD	0.187					0.19
Slow Controls, HV and Cryo	NEW HIRE POSTDOC1	Research Associate	ND			0.25			0.25
	Paley, Jonathan	Scientist	ND	0.07		0.64			0.71
	Pavlovic, Zarko	Applications Physicist II	ND			0.6			0.60
	Strauss, Thomas	Scientist	TD	0.076					0.08
	Velez, Gueorgui	Senior Scientist	TD	0.06					0.06
	Wickremasinghe, Don Athula	Research Associate	AD				1		1.00
	Abeyaratna	Research Associate	AD						1.00
Neutrino Cross-Sections and DUNE Near Detector	Acciarri, Roberto	Applications Physicist II	ND		0.3				0.30
	Balasubramanian, Supraja	Research Associate	ND		1				1.00
	Basque, Vincent	Research Associate	ND		0.75				0.75
	Bellantoni, Leo	Senior Scientist	ND	0.76					0.76
	Betancourt Vega, Minerva	Associate Scientist	ND		0.9			0.05	0.95
	Bross, Alan	Senior Scientist	ND		0.9				0.90
	Crisler, Michael	Senior Scientist	PPD		0.5				0.50
Neutrino Cross-Sections and DUNE Near Detector	Duffy, Kirsty	Research Associate	ND	0.01		0.99			1.00
	Gramellini, Elena	Research Associate	ND			0.8			0.80
	Miao, Ting	Senior Scientist	ND	0.98			0.02		1.00
	NEW HIRE POSTDOC2	Research Associate	ND					0.25	0.25
	Raaf, Jennifer	Senior Scientist	ND	0.25			0.05	0.05	0.35
	Siler, Louise	Scientist	ND	0.05			0.83		0.88
	Bleszczynski, Flor	Applications Physicist I	ND					0.3	0.30
Neutrino Cross-Sections and DUNE Near Detector	Hahn, Alan	Senior Scientist	ND	0.4				0.38	0.78
	Hahn, Stephen	Applications Physicist III	ND				0.3		0.30
	Ourvivo Escobar, Carlos	Guest Scientist	ND	1					1.00
	Pordes, Stephen	Senior Scientist	ND	0					0.00
Grand Total FTE			13.14	11.29	9.81	5.73	0.98	0.68	41.63
Grand Total k\$			\$4,977	\$3,013	\$2,822	\$1,576	\$294	\$143	\$12,824

# Neutrino Division Org Chart

## NEUTRINO DIVISION

Last Updated: October 29, 2020



# Examples of what Fermilab Neutrino Scientists are \*not\* doing (1)

- Focusing our effort on the 7 areas of focus described in the previous slides means making choices to \*not\* do some things
- Examples –
  - No work on LAr TPC APAs and CPAs
    - Well covered by other institutions
    - Fermilab involvement would not be a game changer
    - Alberto Marchionni is the LBNF/DUNE Project L3 for APAs, but that was an individual request from the Project
  - No work on experiments that recently stopped running
    - Other institutions can handle the long tail of papers from legacy data
    - Fermilab needs to move on to the future
    - e.g. no effort on MiniBooNE or MINOS for several years, almost no effort now on MINERvA

# Examples of what Fermilab Neutrino Scientists are \*not\* doing (2)

- Focusing our effort on the 7 areas of focus described in the previous slides means making choices to \*not\* do some things
- More examples –
  - No work on ANNIE
    - ANNIE is an experiment in BNB to study neutron emission from neutrino events and to prototype LAPPDs
    - Fermilab devotes resources to building and running the experiment
    - Not a step on the way to DUNE. Therefore, Fermilab scientists are not involved in ANNIE research
  - No work on Non-Fermilab Neutrino Experiments
    - No involvement in non-Fermilab neutrino experiments
    - Minor involvement in non-Fermilab experiments where they directly serve the needs of DUNE – e.g. electron scattering at JLab in service of neutrino cross-sections



# Role of Fermilab Neutrino Scientists

- Fermilab Neutrino Scientists...
  - Perform World-class science
  - Interface with the engineers and technicians to leverage the laboratory's outstanding technical resources for the benefit of the neutrino experiments
  - Facilitate and amplify the work of university colleagues and collaborators from other laboratories
- University and Laboratory researchers make excellent teams with complementary strengths – experiments work best when these two groups are knit together

# Role of Fermilab Neutrino Scientists

- Fermilab Neutrino Scientists...
  - Interface with and facilitate access to technical and engineering support staff
    - Critical to safe, efficient, successful detector design, assembly, commissioning, operations
  - Interface with and facilitate access to the computing support staff
    - Critical to data acquisition, data handling and processing, and analysis development
  - Provide continuity and local expertise
    - Readily accessible for visiting students, post-docs, and faculty
  - Aid in forming an intellectual hub at Fermilab that provides an inclusive working environment and helps in diversifying the field
    - Leadership & management of programs supporting the neutrino community

# Fermilab Programs Engaging the Neutrino Community

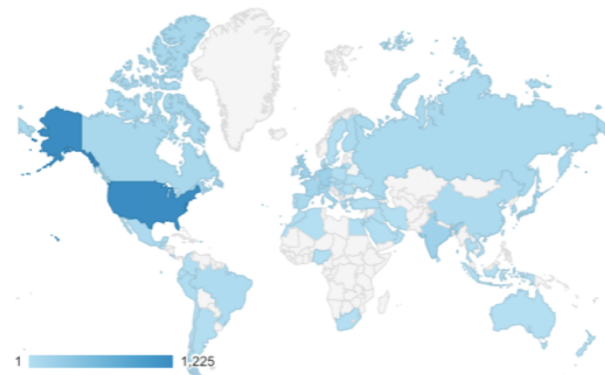
- Intensity Frontier Fellowships
  - Competitive fellowship program to support extended stays at Fermilab for neutrino and muon work
- Neutrino Physics Center
  - Modeled after highly successful LPC for CMS, organizes a wide variety activities
- Seminar and Lecture Series
  - Neutrino Seminar Series, Neutrino University, Topical Workshops & Seminar Series
- International and Summer Student programs
  - Dedicated South American, Indian, Italian programs

**Fermilab Scientists develop, organize, and lead programs that educate, engage, and enable the wider neutrino community**

# Facilitating the Neutrino Community: NEUTRINO 2020

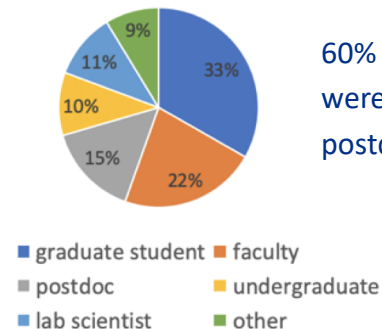
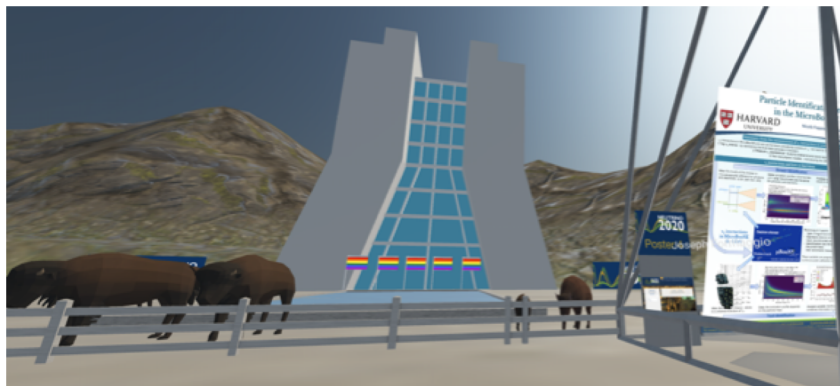


- Fermilab successfully hosted the world for the largest international conference in neutrino physics
- Record attendance
  - 3,469 people from 67 countries connected virtually
  - C.F. in-person conference had ~800 people in recent years
  - participation from all 7 continents (including Antarctica)
- Strong worldwide interest in neutrino science



*participants connected from 67 countries*

- Included a very well-received virtual reality(VR) poster session



60% of attendees were students and postdocs

# Summary of the Briefing

- Neutrinos are a vibrant subfield of particle physics
- Fermilab is well on the way to being the world center for neutrino research
- It all leads to DUNE and Fermilab neutrino scientists are organized to that end
- Fermilab neutrino scientists facilitate the wider neutrino community